APPENDIX D
AIR QUALITY

Acronyms and Abbreviations

ACAM	Air Conformity Applicability Model
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CY	Calendar Year
DPY	Days per Year
EPA	Environmental Protection Agency
ETS/CEM	Emission Tracking System/Continuous Emissions Monitoring
GHG	Greenhouse Gas
GOV	Government Owned Vehicle
HAPs	Hazardous Air Pollutants
lb	Pounds
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
Pb	Lead
$PM_{2.5}$	Particulate Matter With a Diameter Less Than or Equal to 2.5 Microns
PM_{10}	Particulate Matter With a Diameter Less Than or Equal to 10 Microns
ppm	Parts per Million
POV	Personal Operating Vehicle
ROI	Region of Influence
SO_2	Sulfur Dioxide
TP	Target Practice
VMT	Vehicle Miles Travelled
VOC	Volatile Organic Compounds
yr	Year

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AIR QUALITY

This appendix presents detailed assumptions and calculation methodologies used to determine criteria air pollutant emissions associated with the Proposed Action and alternatives.

D.1 Air Quality Program Overview

In order to protect public health and welfare, the United States (U.S.) Environmental Protection Agency (EPA) has developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for six "criteria" pollutants (based on health-related criteria) under the provisions of the CAA Amendments of 1970. There are two kinds of NAAQS: Primary and Secondary standards. Primary standards prescribe the maximum permissible concentration in the ambient air to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards prescribe the maximum concentration or level of air quality required to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (40 Code of Federal Regulations [CFR] 50).

The CAA gives states the authority to establish air quality rules and regulations. These rules and regulations must be equivalent to, or more stringent than, the Federal program. The Alaska Department of Environmental Conservation (DEC) Air Quality Division administers the state's air pollution control program under the authority of the Federal CAA and Amendments, Federal Regulations, and state laws.

Alaska has adopted the Federal standards. The Federal and state of Alaska ambient air quality standards are presented in Table D.1-1.

Based on measured ambient air pollutant concentrations, the EPA designates areas of the United States as having air quality better than (attainment) the NAAQS, worse than (nonattainment) the NAAQS, and unclassifiable. The areas that cannot be classified (on the basis of available information) as meeting or not meeting the NAAQS for a particular pollutant are "unclassifiable" and are treated as attainment until proven otherwise. Attainment areas can be further classified as "maintenance" areas, which are areas previously classified as nonattainment but where air pollutant concentrations have been successfully reduced to below the standard. Maintenance areas are under special maintenance plans and must operate under some of the nonattainment area plans to ensure compliance with the NAAQS. The Anchorage Borough is attainment for all criteria pollutants in which JBER is located. EAFB is located in Fairbanks North Star Borough, which is also in attainment for all criteria pollutants.

A general conformity analysis is required if (1) the action's direct and indirect emissions have a Potential to Emit (PTE) one or more of the six criteria pollutants at or above emission rates shown in Table D-2 or Table D.1-3, or (2) the action's direct and indirect emissions of any criteria pollutant represent 10 percent of a nonattainment or maintenance area's total emissions inventory for that pollutant.

Table D.1-1.Summary of National and State Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Federal Primary NAAQS	Federal Secondary NAAQS
Carbon Monoxide (CO)	8-hour	9 ppm (10 mg/m^3)	No standard
	1-hour	35 ppm (40 mg/m^3)	No standard
Lead (Pb)	rolling 3-month Average	015 [1]	015
Nitrogen Dioxide (NO_2)	Annual	0.053 ppm [2] (100 µg/m3)	0.053 ppm (100
	1-hour	100 ppb	No standard [8]
Particulate Matter ≤10 Micrometers (PM_{10})	24-hour	150 µg/m^3	150 µg/m³
Particulate Matter <2.5 Micrometers ($PM_{2.5}$)	Annual	15 µg/m³	15 µg/m³
	24-hour	35 µg/m³	35 µg/m³
Ozone (O_3)	8-hour	0.075 ppm [3] (157 µg/m³)	0.075 ppm (157 µg/m³)
Sulfur Dioxide (SO_2)	3-hour	No standard	0.50 ppm [8] (1300 µg/m³)
	1-hour	75 ppb [4]	No standard

Notes:

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m³ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3-years) and related implementation rules remain in place. In 1997 EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Key:

µg/m3 = micrograms per cubic meter ppm = parts per million

ppb parts per billion

Source: EPA, 2011 (Federal Standards), DEC, 2012 (State Standards)

Each state is required to develop a state implementation plan (SIP) that sets forth how CAA provisions will be imposed within the state. The SIP is the primary means for the implementation, maintenance, and enforcement of the measures needed to attain and maintain the NAAQS within each state and includes control measures, emissions limitations, and other provisions required to attain and maintain the ambient air quality standards. The purpose of the SIP is twofold. First, it must provide a control strategy that will result in the attainment and maintenance of the NAAQS. Second, it must demonstrate that progress is being made in attaining the standards in each nonattainment area.

Table D.1-2. Emission Rates for Criteria Pollutants in Nonattainment Areas*

Pollutant		Emission Rate (tons/year)
Ozone (Volatile Organic Compounds [VOCs] or NO_x)		
	Serious nonattainment areas	50
	Severe nonattainment areas	25
	Extreme nonattainment areas	10
	Other ozone nonattainment areas outside an ozone transport region	100
Marginal and moderate nonattainment areas inside an ozone transport region		
	VOC	50
	NO_x	100
CO: All nonattainment areas		100
SO_2 or NO_2: All nonattainment areas		100
PM_{10}		
	Moderate nonattainment areas	100
	Serious nonattainment areas	70
$PM_{2.5}$		
	Direct emissions	100
	SO_2	100
	NO_x (unless determined not to be a significant precursor)	100
	VOC or ammonia (if determined to be significant precursors)	100
Pb: All nonattainment areas		25

**De minimus* threshold levels for conformity applicability analysis
Source: EPA 2006

Table D.1-3. Emission Rates for Criteria Pollutants in Attainment (Maintenance) Areas*

Pollutant		Emission Rate (tons/year)
Ozone (NO_x, SO_2, or NO_2): All maintenance areas		100
Ozone (VOCs)		
	Maintenance areas inside an ozone transport region	50
	Maintenance areas outside an ozone transport region	100
CO: All maintenance areas		100
PM_{10}: All maintenance areas		100
$PM_{2.5}$		
	Direct Emissions	100
	SO_2	100
	NO_x (unless determined not to be a significant precursor)	100
	VOC or ammonia (if determined to be significant precursors)	100
Pb: All maintenance areas		25

**De minimus* threshold levels for conformity applicability analysis.
Source: EPA 2006

In attainment areas, major new or modified stationary sources of air emissions on and in the area are subject to Prevention of Significant Deterioration (PSD) review to ensure that these sources are constructed without causing significant adverse deterioration of the clean air in the area. A major new source is defined as one that has the potential to emit any pollutant regulated under the CAA in amounts equal to or exceeding specific major source thresholds; that is, 100 or 250 tons/year based on the source's industrial category. A major modification is a physical change or change in the method of operation at an existing major source that causes a significant "net emissions increase" at that source of any regulated pollutant. Table D.1-4 provides a tabular listing of the PSD Significant Emissions Rate (SER) thresholds for selected criteria pollutants (EPA 1990).

Table D.1-4. Criteria Pollutant Significant Emissions Rate IncreasesUnder PSD Regulations

Pollutant	Significant Emissions Rate (tons/year)
PM_{10}	15
$PM_{2.5}$	10
Total Suspended Particulate (TSP)	25
SO_2	40
NO_x	40
Ozone (VOCs)	40
CO	100

Source: 40 CFR 51.

The goals of the PSD program are to (1) ensure economic growth while preserving existing air quality; (2) protect public health and welfare from adverse effects that might occur even at pollutant levels better than the NAAQS; and (3) preserve, protect, and enhance the air quality in areas of special natural recreational, scenic, or historic value, such as national parks and wilderness areas. Sources subject to PSD review are required by the CAA to obtain a permit before commencing construction. The permit process requires an extensive review of all other major sources within a 50-mile radius and all Class I areas within a 62-mile radius of the facility. Emissions from any new or modified source must be controlled using Best Available Control Technology. The air quality, in combination with other PSD sources in the area, must not exceed the maximum allowable incremental increase identified in Table D.1-5. National parks and wilderness areas are designated as Class I areas, where any appreciable deterioration in air quality is considered significant. Class II areas are those where moderate, well-controlled industrial growth could be permitted. Class III areas allow for greater industrial development. Mandatory Prevention of Significant Deterioration (PSD) No mandatory Federal PSD Class I areas are located within the ROI. The nearest PSD Class I area is Denali National Park, which is approximately 100 miles north-northwest of JBER and is approximately 90 miles from EAFB.

Table D.1-5. Federal Allowable Pollutant Concentration Increases Under PSD Regulations

Pollutant	Averaging Time	Maximum Allowable Concentration ($\mu g/m^3$)		
		Class I	Class II	Class III
PM_{10}	Annual 24-hour	4 8	17 30	34 60
SO_2	Annual 24-hour 3-hour	2 5 25	20 91 512	40 182 700
NO_2	Annual	2.5	25	50

Source: 40 CFR 51

The Division of Air Quality, Air Monitoring, and Quality Assurance Program operates and oversees air quality monitoring networks throughout Alaska. The purpose is to monitor, assess and provide information on statewide ambient air quality conditions and provide technical assistance in developing monitoring plans for air monitoring projects (DEC 2010).

The air quality monitoring network is used to identify areas where the ambient air quality standards are being violated and plans are needed to reduce pollutant concentration levels to be in attainment with the standards. Also included are areas where the ambient standards are being met, but plans are necessary to

ensure maintenance of acceptable levels of air quality in the face of anticipated population or industrial growth.

The result of this attainment/maintenance analysis is the development of local and statewide strategies for controlling emissions of criteria air pollutants from stationary and mobile sources. The first step in this process is the annual compilation of the ambient air monitoring results, and the second step is the analysis of the monitoring data for general air quality, exceedances of air quality standards, and pollutant trends.

D.2 Regulatory Comparisons

The CAA Section 176(c), General Conformity, requires Federal agencies to demonstrate that their proposed activities would conform to the applicable SIP for attainment of the NAAQS. General conformity applies only to nonattainment and maintenance areas. If the emissions from a Federal action proposed in a nonattainment area exceed annual *de minimis* thresholds identified in the rule, a formal conformity determination is required of that action. The thresholds are more restrictive as the severity of the nonattainment status of the region increases. Since the project region is designated as attainment for all criteria pollutants (EPA 2012). The criteria pollutants are compared to Anchorage Borough emissions, which are in attainment.

For the analysis, in order to evaluate air emissions and their impact on the overall ROI, the emission associated with the project activities were compared with the total emissions on a pollutant-by-pollutant basis for the ROI's 2008 National Emissions Inventory (NEI) data version 3. Potential impacts to air quality are evaluated with respect to the extent, context, and intensity of the impact in relation to relevant regulations, guidelines, and scientific documentation. The Council on Environmental Quality (CEQ) defines significance in terms of context and intensity in 40 CFR 1508.27. This requires that the significance of the action must be analyzed in respect to the setting of the proposed action and based relative to the severity of the impact. The CEQ NEPA Regulations (40 CFR 1508.27(b)) provide ten key factors to consider in determining an impact's intensity. To provide a more conservative analysis, the county were selected as the ROI instead of the EPA-designated Air Quality Control Region (AQCR), which is a much larger area

D.3 Project Equations for Calculating Emissions

D.3.1 Construction Emissions

Calculations for construction emissions were completed using the calculation methodologies described in the U.S. Air Force Air Conformity Applicability Model (ACAM). As previously indicated, a conformity determination is not required since the Richland County is designated as attainment for all criteria pollutants.

The ACAM version 4.5.0 was used to provide a level of consistency with respect to emission factors and calculations. The ACAM evaluates the individual emissions from different sources associated with the construction phases. These sources include grading activities, construction worker trips, and stationary equipment (such as saws and generators) (Air Force 2010).

The Proposed Action calls for the facility modification activities at JBER, which is located in Anchorage Borough.

D.3.2 Mobile and Stationary Construction Equipment Emissions

Equipment emissions are combustive emissions from equipment engines and are calculated using the following equation:

$$E_{constr\text{-}eq} = N * HP * LF * OT * EF / 454$$

Where: $E_{constr\text{-}eq}$ = Emissions of criteria pollutant from construction equipment (pounds [lbs]/day/10 acres)

N = Number of pieces of equipment

HP = Horsepower of equipment (hp)

LF = Load factor of equipment (percent)

OT = Operating time (hours/day)

EF = Emission Factor for criteria pollutant (g/hp-hr)

454 = Conversion factor from grams to pounds (grams/pound)

Grading activities are divided into grading equipment emissions and grading operation emissions. To complete the site preparation and grading activities it is assumed that one grader, one rubber tired dozer, one tractor/loader/backhoe, and one water truck are used per 435,600 square feet (10 acres). Emissions from construction equipment are determined assuming the use of one crane, two forklifts, and one tractor/loader/backhoe per 435,600 square feet (10 acres) of building construction (Air Force 2010).

ACAM 4.5 uses average horsepower and load factor settings for each piece of equipment. It has set the usual hours per day of operation for each piece of equipment as determined for a 10-acre construction site. With these assumptions, the emissions from construction-equipment are calculated as follows:

$$E_{grading} = E_{constr\text{-}eq} * [A / 435{,}600] * OD / 2000$$

Where: $E_{grading}$ = Emissions of criteria pollutant from grading (tons/year [yr])

$E_{constr\text{-}eq}$ = Emissions of criteria pollutant from construction equipment (lbs/day/10 acres)

A = Area of construction/grading (square feet)

435,600 = Conversion from 10 acres (435,600 square feet) to emissions per square feet

OD = Operating days (days/year)

2000 = Conversion from pounds to tons (lbs/ton)

D.3.3 Architectural Coating Emissions

Paints, varnishes, primers, and other surface coatings release Volatile Organic Compounds (VOC) through the evaporation of solvents. The following calculations were performed to determine VOC emissions.

Determine the total interior and exterior surface square footage:

$$Residential\ Interior = \#\ Multi\text{-}Family\ Units + \#\ Single\ Family\ Units * 1000 * 2.7 * 0.75$$

*Residential Exterior = # Multi-Family Units + # Single Family Units * 1000 * 2.7 * 0.25*

*Non-Residential Interior = Total building sq. footage * 2.0 * 0.75*

*Non-Residential Exterior = Total building sq. footage * 2.0 * 0.25*

Total Surface Coating Area (ft²) = Res. Int. + Res.Ext. + Non-Res. Int. + Non-Res. Ext.

Where: Residential/Non-Residential Interior and Residential/Non-Residential Exterior = Total interior or exterior surface area (ft²)

Multi-Family Units = User input number of units (assume 1000 ft² per unit)

Single-Family Units = User input number of units (assume 1000 ft² per unit)

1000 = Average square footage of multi- and single-family units

2.7 or 2.0 = Conversion Factor from total building square footage to surface area to be coated

0.75 or 0.25 = Percentages used to account for the total coatings assumed to be interior and exterior

Emissions are then calculated:

$$VOC_{AT} = 250 / 454 * 3.485 / 180 * \text{Total Surface Coating Area}$$

Where: 250 = Grams of VOC per liter of paint

454 = Conversion factor from grams to pounds (g/lbs)

3.785 = Conversion factor from liters to gallons (L/gal)

180 = Conversion factor from square feet to gallons (ft²/gal)

2000 = Conversion factor from pounds to tons (lbs/ton)

These algorithms assume that emissions associated with all coating applications and drying is evenly distributed over the entire construction phase (Air Force 2010).

D.3.4 Grading Operations

Grading operation emissions are calculated using a similar equation from the Sacramento Air Quality Management District and South Coast Air Quality Management District (Air Force 2010). This calculation includes grading and truck hauling emissions.

Emission Calculation:

$$PM_{10} \text{ (tons/yr)} = 60.7 \text{ (lb/acre/day)} * \text{Acres} * DPY_1/2000$$

Where: Acres = number of gross acres to be graded during Phase I construction

DPY_1 = number of days per year used for grading during Phase I construction

2000 = conversion factor from pounds to tons

The calculations assumed that there were no controls used to reduce fugitive emissions. In addition, it was assumed that construction activities would occur within the one Calendar Year (CY) in which the project would be implemented (365 days), and that grading activities would represent 50 percent of that

total, or 182 days. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (Air Force 2010).

D.3.5 Architectural Coating Emissions

Paints, varnishes, primers, and other surface coatings release VOC through the evaporation of solvents. The following calculations were performed to determine VOC emissions.

Determine the total interior and exterior surface square footage:

*Residential Interior = # Multi-Family Units + # Single Family Units * 1000 * 2.7 * 0.75*

*Residential Exterior = # Multi-Family Units + # Single Family Units * 1000 * 2.7 * 0.25*

*Non-Residential Interior = Total building sq. footage * 2.0 * 0.75*

*Non-Residential Exterior = Total building sq. footage * 2.0 * 0.25*

Total Surface Coating Area (ft²) = Res. Int. + Res.Ext. + Non-Res. Int. + Non-Res. Ext.

Where: Residential/Non-Residential Interior and Residential/Non-Residential Exterior = Total interior or exterior surface area (ft²)

Multi-Family Units = User input number of units (assume 1000 ft² per unit)

Single-Family Units = User input number of units (assume 1000 ft² per unit)

1000 = Average square footage of multi- and single-family units

2.7 or 2.0 = Conversion Factor from total building square footage to surface area to be coated

0.75 or 0.25 = Percentages used to account for the total coatings assumed to be interior and exterior

Emissions are then calculated:

$$VOC_{AT} = 250 / 454 * 3.485 / 180 * \text{Total Surface Coating Area}$$

Where: 250 = Grams of VOC per liter of paint

454 = Conversion factor from grams to pounds (g/lbs)

3.785 = Conversion factor from liters to gallons (L/gal)

180 = Conversion factor from square feet to gallons (ft²/gal)

2000 = Conversion factor from pounds to tons (lbs/ton)

These algorithms assume that emissions associated with all coating applications and drying is evenly distributed over the entire construction phase (Air Force 2010).

D.3.6 Construction Worker Trips

Construction worker trips during the construction phases of the project are calculated and represent a function of the number of residential units to be constructed and/or square feet of commercial construction.

Calculation:

*Multi-Family (trips/day) = 0.36 (trips/unit/day) * Number of Multi-Family Units*

*Single-family (trips/day) = 0.72 (trips/unit/day) * Number of Single-Family Units*

*Commercial/Retail Building (trips/day) = 0.32 (trip/1,000 ft²/day) * Area of commercial/retail building (1,000 ft²)*

*Office/Employment (trips/day) = 0.42(trips/1,000 ft²/day) * Area of Office/Employment Units (1,000 ft²)*

Total Daily Trips (TRIPS) (trips/day) = Multi-Family + Single-Family + Commercial/Retail + Office/employment.

Total daily trips are applied to the following factors depending on the corresponding project years (Table D.3-1). TRIPS are the total daily trips calculated above and 454 is a conversion factor from grams to pounds. The following calculation is performed using the appropriate emission factor for each of the pollutants:

$$E_{CPppd}\ (lbs/day) = EF\ (g/trip) * TRIPS / 454$$

Table D.3-1. Vehicle Emission Factors

Year	Vehicle Emission Factors (grams/trip)				
	CO	NO_x	PM_{10}	SO_2	VOC
2010 – 2014	15.184	0.661	0.0047	0.0005	0.678
2015 – 2019	10.371	0.492	0.0047	0.0003	0.437

To convert from pounds per day to tons per year:

$$E_{CPtpy}\ (tons/yr) = E_{CPppd}\ (lbs/day) * DPY_{II} / 2000$$

Where: E_{CPtpy} = Emission criteria pollutant annual tons (tons/year)

E_{CPppd} = Emission of criteria pollutant pounds per day (lbs/day)

2000 = conversion factor from pounds to tons

DPY_{II} = number of days per year during Phase II construction activities

The total square footage of all the construction sites during one year were used to analyze the annual construction emissions and associated worker trips. It was assumed that 100% of the total construction and paved areas would require grading. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (Air Force 2010).

D.3.7 Demolition Emissions

The primary emission occurring from building demolition is particulate matter (PM_{10}). The equation used in ACAM to calculate demolition emissions is:

$$E\ (tons/yr) = 0.00042\ x\ J\ x\ Q/2000$$

Where: J = (N x O x P)/Q

User Input Variables:

J = Building volume handled per day

N = Width of building in feet

O = Length of building in feet

P = Height of building in feet

Q = Number of days (in the calendar year) required to demolish a building

Other Parameters:

0.00042 = Emission factor in pounds of PM_{10} per cubic feet per day

2000 = Conversion factor for converting from pounds to tons

For this document, it was assumed that the buildings were no taller than 60 feet and the width and length were calculated by taking the square root of the given square footage. It was also assumed that all structures would be demolished in one year (260 work days).

D.3.8 Personnel

Emissions relating to the addition of personnel at an installation include miscellaneous area sources, on-road mobile sources: employee commute and government vehicle use, and residential heating. The following calculations were used to determine emissions from additional personnel to the Region of Influence (ROI). The Proposed Action would realign 542 active duty personnel to JBER and EAFB would reduce personnel by 749 active duty and 179 civilian.

D.3.9 Miscellaneous Area Source Emissions

A variety of miscellaneous activities occur on installations that emit air pollutants. These activities are too small and/or too disaggregate to be calculated separately as pertaining to personnel. Emissions are calculated with the following equation

$$E_P \text{ (tons/yr)} = N * 0.0171 / 2000$$

Where: E_P = Emission criteria pollutant annual tons (tons/year)

N = Number of personnel realigned

0.0171 = Emission factor in pounds per person per day of VOC per capita emission.

2000 = conversion factor from pounds to tons

Sources: Air Force 2010

D.3.10 On-Road Base Employee Commute Vehicle Miles Traveled (VMT) Emissions

Emissions from Personal Operating Vehicles (POVs) used by base workers to commute back and forth from the base. This does not include construction worker commuting. The following equation was used for on-road base employee commute emissions.

$$E_P = F * N * (1 - ONBASE) * 2 * COMDIST * EF_P / 454 / 2000$$

Where: E_P = Emission criteria pollutant annual tons (tons/year)

F = Fraction of the year the personnel operate

N = Number of personnel realigned

ONBASE = Fraction of the personnel living on base

COMDIST = One-way commute distance (miles) for off-base personnel

2 = Number of commutes per work day

EF_P = Emission factor for pollutant, p (grams/mile). These factors were determined from MOBILE6 for CO, NO_x, and VOCs for the chosen fleet mix.

454 = Conversion factor from grams to pounds

2000 = Conversion factor from pounds to tons

Sources: Jagielski as referenced in Air Force 2010

D.3.11 On-Road Government Owned Vehicle (GOV) VMT Emissions

Installations maintain GOVs fleets, which will cause emissions on the base. The additional VMTs for GOVs are assumed proportional to additional base personnel. Emissions were calculated using the following equation.

$$E_P = F * N * GOVVMT * EF_P / 454 / 2000$$

Where E_P = Emission criteria pollutant annual tons (tons/year)

F = Fraction of the year the personnel operate

N = Number of personnel realigned

GOVVMT = Per-employee VMT, miles/employee

EF_P = Emission factor for pollutant, p (grams/mile). These factors were determined from MOBILE6 for CO, NO_x, and VOCs for the chosen fleet mix.

454 = Conversion factor from grams to pounds

2000 = Conversion factor from pounds to tons

Sources: Jagielski as referenced in Air Force 2010

D.3.12 Residential Heating Emissions

Emissions occur from the use of residential space heating for realigned personnel. Only the residences of those personnel living on the installation are included. All residential space heaters are assumed to burn natural gas. Emissions are calculated using the following equation.

$$E_P = N * 2.56 * F * ONBASE * RESBTU * EF_P / 2000$$

Where: N = Number of personnel realigned

F = Fraction of the year the personnel operate

ONBASE = Fraction of the personnel living on base

RESBTU = Per capita heating energy requirement, MMBtu/person

2.56 = Number of on-base residents per employee. Assumed 2.56 dependents per realigned personnel based on an average distribution of accompanied and unaccompanied personnel located on base under normal conditions.

EF_P = Emission factor for pollutant, p, for natural gas heating (lb/MMBtu). The factors are as follows: CO = 0.0824, NO_x = 0.1863, VOC = 0.0054, SO_2 = 0.0006 and PM_{10} = 0.0075.

2000 = Conversion factor from pounds to tons

Sources: EPA 1998 and Air Force 2010.

D.3.13 Aircraft Emissions

Aircraft emissions include flight operations as well as auxiliary power units, aerospace ground equipment, and engine trim tests. Aircraft flight emissions by calculated the emissions for each individual pollutant per mode (idle, approach, intermediate, military, and afterburner). The following equation was used.

$$E_{Pmode} = T_{mode}/60 * FFR/1000 * EF * NE$$

Where: E_{Pmode} =

F = Fraction of the year the personnel operate

ONBASE = Fraction of the personnel living on base

RESBTU = Per capita heating energy requirement, MMBtu/person

2.56 = Number of on-base residents per employee. Assumed 2.56 dependents per realigned personnel based on an average distribution of accompanied and unaccompanied personnel located on base under normal conditions.

EF_P = Emission factor for pollutant, p, for natural gas heating (lb/MMBtu). The factors are as follows: CO = 0.0824, NO_x = 0.1863, VOC = 0.0054, SO_2 = 0.0006 and PM_{10} = 0.0075.

2000 = Conversion factor from pounds to tons

D.3.14 Greenhouse Gases

Greenhouse gases are calculated for construction equipment and construction work trips. ACAM 4.5 assumes the number and type of construction equipment based on acreage. Using this information the number of pieces of construction equipment is determined for GHG emissions. Emissions are calculated using the following equation:

$$E_{CO2e} = F * \sum (EF_{p,fuel} * GWP) / 2000$$

Where: E_{CO2e} = carbon dioxide equivalent emission (tons/year)

F = annual fuel use (gal/year)

$EF_{p,fuel}$ = Emission factor (lb/gal) for fuel type for each pollutant

GWP = Global warming potential (see Table D.3-2)

2000 = conversion factor from pounds to tons

Table D.3-2. GHG Emission Factors and Global Warming Potential

Pollutant	Global Warming Pot.	Emission Factors pound/gallon	
		Diesel[1]	Gasoline[1]
CO2	1	22.4	19.5
CH4	21	0.0012787	0.00110229
N2O	310	0.0005732	0.000485

Source: CCR 2009

For construction equipment, it was assumed that equipment use diesel fuel at a rate of 3.27 gallons per hour and operates 8 hours a day, 5 days a week, and 52 weeks per year.

To calculate worker and employee commutes it was assumed 30 miles per day and the gasoline-fueled vehicle gets 22.1 miles per gallon.

Aircraft GHG emissions were determined using the equation above with an emission factor for JP8 fuel and fuel flow rates were established using default fuel flow rates and time in mode for USAF combat aircraft.

D.3.15 National Emissions Inventory

The National Emissions Inventory (NEI) is operated under the U.S. Environmental Protection Agency's (EPA's) Emission Factor and Inventory Group, which prepares the national database of air emissions information with input from numerous state and local air agencies, tribes, and industries. The database contains information on stationary and mobile sources that emit criteria air pollutants and Hazardous Air Pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on a yearly basis. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates for individual point or major sources (facilities), as well as county-level estimates for area, mobile, and other sources, are currently available for years 1996 and 1999 for criteria pollutants and HAPs.

Criteria air pollutants are those for which the EPA has set health-based standards. Four of the six criteria pollutants are included in the NEI database:

1. Carbon Monoxide (CO)
2. Nitrogen Oxides (NO_x)
3. Sulfur Dioxide (SO_2)
4. Particulate Matter (PM_{10} and $PM_{2.5}$)

The NEI also includes emissions of VOCs, which are ozone precursors, emitted from motor vehicle fuel distribution and chemical manufacturing, as well as other solvent uses. VOCs react with nitrogen oxides in the atmosphere to form ozone. The NEI database defines three classes of criteria air pollutant sources:

Point Sources - Stationary sources of emissions, such as an electric power plant, that can be identified by name and location. A "major" source emits a threshold amount (or more) of at least one criteria pollutant and must be inventoried and reported. Many states also inventory and report stationary sources that emit amounts below the thresholds for each pollutant.

Area Sources - Small point sources such as a home or office building or a diffuse stationary source such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. Dry cleaners are one example; for instance, a single dry cleaner within an inventory area typically will not qualify as a point source, but collectively the emissions from all of the dry cleaning facilities in the inventory area may be significant and therefore must be included in the inventory.

Mobile Sources - Any kind of vehicle or equipment with a gasoline or diesel engine (such as an airplane or ship).

The following are the main sources of criteria pollutant emissions data for the NEI:

For Electric Generating Units - EPA's Emission Tracking System/Continuous Emissions Monitoring Data (ETS/CEM) and Department of Energy fuel use data.

For Other Large Stationary Sources - state data and older inventories where state data were not submitted.

For On-Road mobile Sources - the Federal Highway Administration's estimate of vehicle miles traveled and emission factors from EPA's MOBILE Model.

For Non-Road Mobile Sources - EPA's NONROAD Model.

For Stationary Area Sources - state data, EPA-developed estimates for some sources and older inventories where state or EPA data were not submitted.

State and local environmental agencies supply most of the point source data. EPA's Clean Air Market program supplies emissions data for electric power plants.

D.4 References

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EPA 2006. Final Rule: $PM_{2.5}$ De Minimis Emission Levels for General Conformity Applicability, 40 Code of Federal Regulations Parts 51.853 and 93.152. Volume 71, Number 136. July 17, 2006. Accessed through http://www.epa.gov/fedrgstr/EPA-AIR/2006/July/Day-17/a11241.htm, in November 2006.

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